A reconstruction of Briggs' Logarithmorum chilias prima (1617)

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6 December 2010

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I ever rest a lover of all them that love the Mathematickes

Henry Briggs, preface to [47]

1 Henry Briggs

Henry Briggs (1561–1631)[1] is the author of the first table of decimal logarithms, published in 1617, and of which this document gives a reconstruction.

After having been educated in Cambridge, Briggs became the first professor of geometry at Gresham College, London, in 1596 [74, p. 120], [65, p. 20], [80]. Gresham College was England's scientific centre for navigation, geometry, astronomy and surveying.[2] Briggs stayed there until 1620, at which time he went to Oxford, having been appointed the first Savilian Professor of Geometry in 1619 [65, p. 24].

While at Gresham College, Briggs became friends with Edward Wright. He also seems to have spent time doing research in astronomy and navigation [65, pp. 29–30]. Briggs had in particular published several tables for the purpose of navigation in 1602 and 1610 [81]. Moreover, several of Briggs' tables were published under the name of others [65, p. 8].[3]

2 Napier's *Descriptio* (1614)

In 1614, John Napier (1550–1617) published his *Mirifici logarithmorum canonis descriptio*, the description of his table of logarithms [46, 62].

It is through this work that Briggs was early exposed to the theory of logarithms.[4] After Napier's publication, Briggs went to visit him in Scotland in the summers of 1615 and 1616 and they agreed on the need to reformulate

[1] Briggs was baptized on February 23, 1560 (old style), which is 1561 new style. He died on January 26, 1630 (old style), which is 1631 new style [39].

[2] Gresham College was a very fluctuating institution, and the main reason for its claim to scientific responsability was the work and influence of Briggs. The flourishing period of Gresham College ended with the death of Henry Gellibrand in 1636 [2, p. 20].

[3] For more biographical information on Briggs, consult Smith [63], Ward [74], Sonar [65] and Kaunzner [40]. Sonar gives an overview of Briggs' works prior to his tables of logarithms [65].

[4] There is a manuscript entitled *Imitatio Nepeirea*, which might be related to the first contact that Briggs had with Napier's work, but we have not seen it and cannot comment very much upon it. It was mentioned by Stewart and Minto in 1787 [67, p. 13] and they dated it from 1614, but Glaisher in 1873 [26, p. 382] considered that it was written about 1623 and was of no particular value or interest. John Pell also had a copy of this manuscript, see [43, p. 254].

the logarithms, a task that Briggs took over.[5]

Napier had devised logarithms in which the logarithm of 10^7 (the whole sine) was 0. He had felt that the system was not totally adequate, but he decided no longer to change it, except if his health would permit it [65, p. 35–36]. The new logarithms designed by Briggs and Napier would have $\log 1 = 0$ and $\log 10$ or $\log \frac{1}{10}$ equal to 1. During his second visit to Napier, Briggs showed him the first calculations with the new system.

3 Wright's translation (1616)

Briggs' friend Edward Wright (1561–1615) [54] had translated Napier's *Descriptio*, but died soon afterwards. Briggs then completed the publication of the translation which appeared in 1616 [47]. In this work, there is a chapter on a graphical method to find proportional parts, invented by Wright, but written by Briggs. At the time of Wright's death, he had apparently left a diagram without explanations (figure 1), and Briggs resolved to clarify it. His contribution is described in detail by Sonar, who partly reproduces Briggs' text [65]. Given three numbers, Briggs explained how to find the fourth proportional. Briggs considered the example given on page 81 of Wright's translation, where the angle to which the (Napierian) logarithm 141766 corresponds is sought, but where only two surrounding values are found in the table. By mere linear interpolation, Briggs found the value of the angle, which is also the one given in Wright's translation. Briggs also explained how Wright's "triangular table" could be used for the same purpose.

Briggs also wrote a preface to the reader for Wright's translation, in which he stressed that the tables can be used not only for trigonometric calculations, but also for computing various proportional means or interest tables, although he does not detail the computations.

4 Briggs' table (1617)

When Napier's last book, the *Rabdologia*, was published in 1617, it contained a dedication to Lord Chancellor Seton. In it, Napier was mentioning the new logarithms [48].

[5]The exact dates of Briggs' visits to Napier are not known and because of the change in the calendar, it is even possible that the second visit occurred in early 1617 [40]. Their first meeting has been recounted by the astrologer William Lilly who writes that Napier and Briggs supposedly stayed for almost fifteen minutes without speaking in admiration for one another [52, pp. 408–409]. There is probably some exaggeration in this account, especially since Lilly was not an eyewitness of the original events.

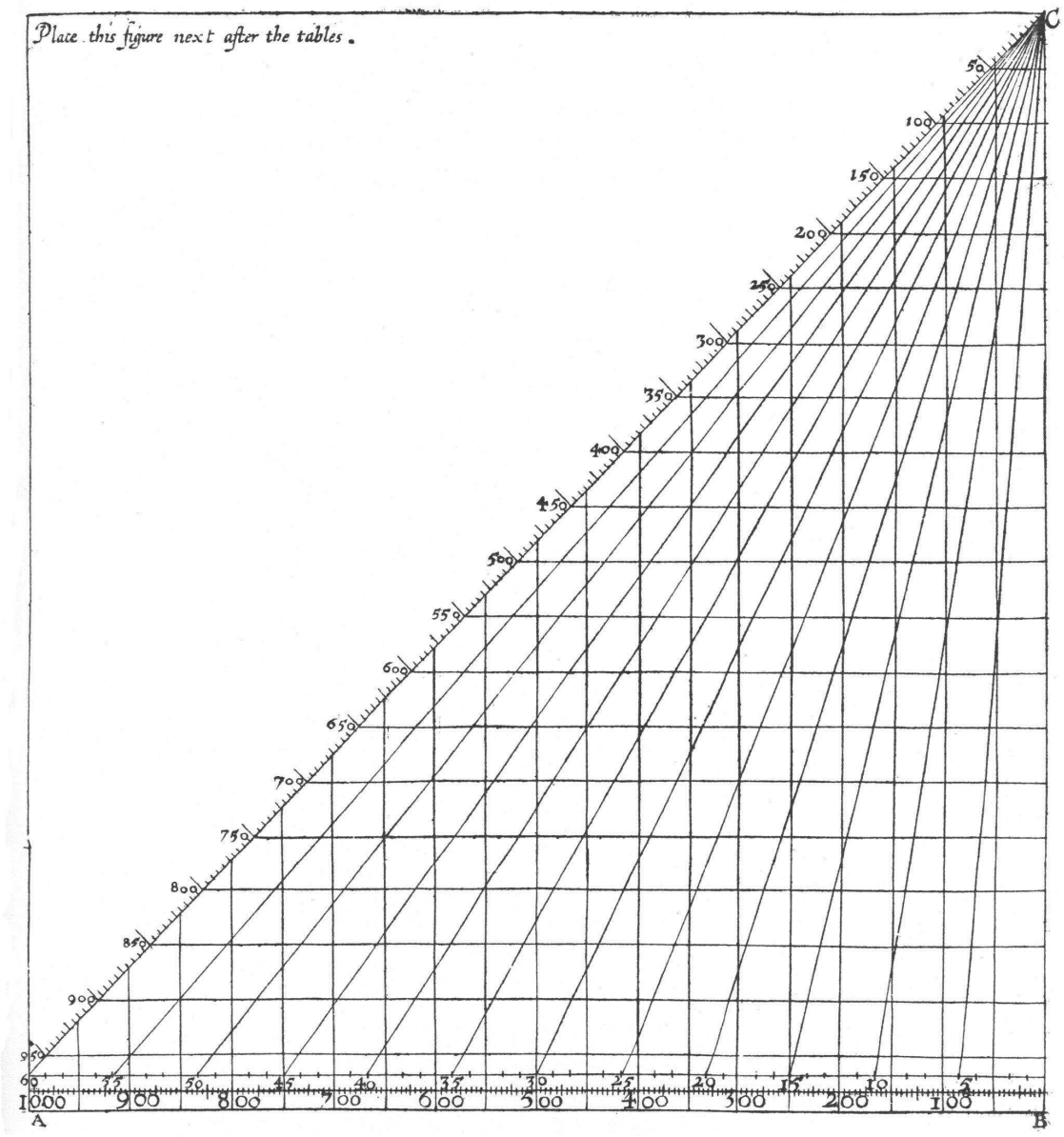

Figure 1: Wright's triangular table for finding proportional parts, published in 1616 [47].

These new logarithms were published by Briggs in 1617. It was a small booklet of 16 pages, privately printed, of which the first page was an introduction, and the remaining 15 pages were tables.[6] Each page contained two columns of 34 logarithms and a total of 67 or 68 logarithms, depending on the pages. Three consecutive columns seem to hold exactly 100 logarithms,[7] and the 15 pages of tables gave the logarithms from 1 to 1000, to 14 decimal places.[8] A reproduction of the text and a recomputation of the tables is given at the end of this document. The original booklet is very rare and bears neither a date, nor the name of an author.[9]

5 Briggs' methods

Briggs' booklet does not describe the process by which Briggs computed his logarithms. Napier's *Constructio* [49], published in 1619, hinted to possible ways to compute decimal logarithms, and Briggs would develop a number of methods and expound them in 1624 in his *Arithmetica logarithmica*, which gave the logarithms of all integers from 1 to 20000 and from 90001 to 100000, also to 14 places [61]. We therefore refer the reader to our analysis of Briggs' main table of logarithms for more details on his methods.

6 Accuracy

According to Archibald, Briggs' table was astonishingly accurate [3]. He reported only 153 errors in the 14th decimal place, 150 being unit errors, and 3 being two-unit errors at $N = 154,\ 239,\ 863$. As we have not seen the complete original table, we cannot check these errors. 121 of these errors are repeated in the *Arithmetica logarithmica* [8]. The first two pages of tables (reproduced by Thompson [69]) contain only three one-unit errors of the last

[6] A facsimile of the first three pages (including the introduction) of Briggs' book was given by Thompson [69]. The text of the one-page introduction is given by Davis [13] and Macdonald [51, pp. 164–165]. Jagger reproduces the second page of tables [38, p. 59]. Archibald gives the size of the booklet as $9.3\,\mathrm{cm} \times 15.5\,\mathrm{cm}$ [3].

[7] Since we saw only a few pages of the booklet, our analysis is currently tentative.

[8] Some accounts of Briggs' table give an incorrect number of places, and it is to be assumed that their authors have not seen the original table. Gerhard, and later Cantor and Tropfke, for instance, write that the logarithms were given to eight places [22, p. 115], [11, p. 738], [70, p. 152], one presumably copying on the other. Such an error is mentioned earlier by Glaisher [25, pp. 296–297] and goes back at least to Hutton [36, p. 34].

[9] On the few known copies, see Archibald [3] and Kaunzner [40, p. 190]. Kaunzner writes that a second edition appeared in 1626, but this may be a confusion with De Decker and Vlacq's volume [40, p. 191], [14].

place (on the first page, $\log 37 = \ldots 6700$ instead of $\ldots 6699$, and on the second page $\log 118 = \ldots 0612$ instead of $\ldots 0613$ and $\log 131 = \ldots 5577$ instead of $\ldots 5576$). The remaining pages apparently contain a higher ratio of errors.

7 Structure of the tables and recomputation

Briggs' table was recomputed using the GNU `mpfr` multiple-precision floating-point library developed at INRIA [20], and gives the exact values. The comparison of our table and Briggs' will therefore immediately show where Briggs' table contains errors.

However, we stress again that we have not seen the entire 1617 booklet, but only the introductory text and the first two pages of tables. Our reconstruction is therefore an extrapolation, and if there are important deviations in the actual tables, they will be included in a further version of this document, once we have access to the original table.

In the appended reconstruction, we have added a line separating the characteristic from the decimals, as at least one copy of the tables has such lines added with the pencil. The values of the numbers are not exactly faithful to the original table, as Briggs dropped some of the digits when they were repeated, but apparently not always consistently. Starting at 101, the numbers seem to be written in full only for multiples of 5, but we are not sure that this scheme goes on after 134. We have therefore always written these numbers in full and might amend them in a future version.

References

The following list covers the most important references[10] related to Briggs' tables. Not all items of this list are mentioned in the text, and the sources which have not been seen are marked so. We have added notes about the contents of the articles in certain cases.

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[9] Henry Briggs and Henry Gellibrand. *Trigonometria Britannica*. Gouda: Pieter Rammazeyn, 1633. [The tables were reconstructed by D. Roegel in 2010. [60]]

[10] **Note on the titles of the works:** Original titles come with many idiosyncrasies and features (line splitting, size, fonts, etc.) which can often not be reproduced in a list of references. It has therefore seemed pointless to capitalize works according to conventions which not only have no relation with the original work, but also do not restore the title entirely. In the following list of references, most title words (except in German) will therefore be left uncapitalized. The names of the authors have also been homogenized and initials expanded, as much as possible.

The reader should keep in mind that this list is not meant as a facsimile of the original works. The original style information could no doubt have been added as a note, but we have not done it here.

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LOGARITHMORVM
Chilias Prima

Quam autor typis excudendam curauit non eo concilio, vt publici iuris fieret ; sed partim, vt quorundam suorum necessariorum desiderio priuatim satisfaceret : partim, vt eius adiumento, non solum Chiliadas aliquot insequentes ; sed etiam integrum Logarithmorum Canonem, omnium Triangulorum calculo inseruientem commodius absolueret. Habet enim Canonem Sinuum à se ipso, ante Decennium per æquationes Algebraicas, & differentias ipsis Sinubus proportionales, pro singulis Gradibus & graduũ centesimis, à primis fundamentis accurate extructũ : quem vna cum Logarithmis adiunctis, volente Deo, in lucem se daturum sperat, quam primum commode licuerit.

Quod autem hi Logarithmi, diuersi sint ab ijs, quos Clarissimus inuentor, memoriæ semper colendæ, in suo edidit Canone Mirifico ; sperandum, eius librũ posthumum, abunde nobis propediem satisfacturum. Qui autori (cum eum domi suæ, Edinburgi, bis inuisseret, & apud eum humanissime exceptus, per aliquot septimanas libentissime mansisset ; eique horum partem præcipuam quam tum absoluerat ostendisset) suadere non destitit, vt hunc in se laborem susciperet. Cui ille non inuitus morem gessit.

In tenui ; sed non tenuis, fructusve laborve.

Briggs' 1617 table of logarithms (reconstruction, D. Roegel, 2010)

	Logarithmi.		*Logarithmi.*
1	00000,00000,00000	34	15314,78917,04226
2	03010,29995,66398	35	15440,68044,35028
3	04771,21254,71966	36	15563,02500,76729
4	06020,59991,32796	37	15682,01724,06699
5	06989,70004,33602	38	15797,83596,61681
6	07781,51250,38364	39	15910,64607,02650
7	08450,98040,01426	40	16020,59991,32796
8	09030,89986,99194	41	16127,83856,71974
9	09542,42509,43932	42	16232,49290,39790
10	10000,00000,00000	43	16334,68455,57959
11	10413,92685,15823	44	16434,52676,48619
12	10791,81246,04762	45	16532,12513,77534
13	11139,43352,30684	46	16627,57831,68157
14	11461,28035,67824	47	16720,97857,93572
15	11760,91259,05568	48	16812,41237,37559
16	12041,19982,65592	49	16901,96080,02851
17	12304,48921,37827	50	16989,70004,33602
18	12552,72505,10331	51	17075,70176,09794
19	12787,53600,95283	52	17160,03343,63480
20	13010,29995,66398	53	17242,75869,60079
21	13222,19294,73392	54	17323,93759,82297
22	13424,22680,82221	55	17403,62689,49424
23	13617,27836,01759	56	17481,88027,00620
24	13802,11241,71161	57	17558,74855,67249
25	13979,40008,67204	58	17634,27993,56294
26	14149,73347,97082	59	17708,52011,64214
27	14313,63764,15899	60	17781,51250,38364
28	14471,58031,34222	61	17853,29835,01077
29	14623,97997,89896	62	17923,91689,49825
30	14771,21254,71966	63	17993,40549,45358
31	14913,61693,83427	64	18061,79973,98389
32	15051,49978,31991	65	18129,13356,64286
33	15185,13939,87789	66	18195,43935,54187
34	15314,78917,04226	67	18260,74802,70083

	Logarithmi.		*Logarithmi.*
67	18260,74802,70083	101	20043,21373,78264
68	18325,08912,70624	102	20086,00171,76192
69	18388,49090,73726	103	20128,37224,70517
70	18450,98040,01426	104	20170,33339,29878
71	18512,58348,71908	105	20211,89299,06994
72	18573,32496,43127	106	20253,05865,26477
73	18633,22860,12046	107	20293,83777,68521
74	18692,31719,73098	108	20334,23755,48695
75	18750,61263,39170	109	20374,26497,94062
76	18808,13592,28079	110	20413,92685,15823
77	18864,90725,17248	111	20453,22978,78666
78	18920,94602,69048	112	20492,18022,67018
79	18976,27091,29044	113	20530,78443,48342
80	19030,89986,99194	114	20569,04851,33647
81	19084,85018,87865	115	20606,97840,35361
82	19138,13852,38372	116	20644,57989,22692
83	19190,78092,37607	117	20681,85861,74616
84	19242,79286,06188	118	20718,82007,30613
85	19294,18925,71429	119	20755,46961,39253
86	19344,98451,24357	120	20791,81246,04762
87	19395,19252,61862	121	20827,85370,31645
88	19444,82672,15017	122	20863,59830,67475
89	19493,90006,64491	123	20899,05111,43940
90	19542,42509,43932	124	20934,21685,16224
91	19590,41392,32109	125	20969,10013,00806
92	19637,87827,34556	126	21003,70545,11756
93	19684,82948,55394	127	21038,03720,95596
94	19731,27853,59970	128	21072,09969,64787
95	19777,23605,28885	129	21105,89710,29925
96	19822,71233,03957	130	21139,43352,30684
97	19867,71734,26624	131	21172,71295,65576
98	19912,26075,69249	132	21205,73931,20585
99	19956,35194,59755	133	21238,51640,96709
100	20000,00000,00000	134	21271,04798,36481

	Logarithmi.		*Logarithmi.*
134	21271,04798,36481	167	22227,16471,14758
135	21303,33768,49501	168	22253,09281,72586
136	21335,38908,37022	169	22278,86704,61367
137	21367,20567,15641	170	22304,48921,37827
138	21398,79086,40124	171	22329,96110,39215
139	21430,14800,25410	172	22355,28446,90755
140	21461,28035,67824	173	22380,46103,12880
141	21492,19112,65538	174	22405,49248,28260
142	21522,88344,38306	175	22430,38048,68629
143	21553,36037,46506	176	22455,12667,81415
144	21583,62492,09525	177	22479,73266,36181
145	21613,68002,23497	178	22504,20002,30889
146	21643,52855,78444	179	22528,53030,97989
147	21673,17334,74818	180	22552,72505,10331
148	21702,61715,39496	181	22576,78574,86918
149	21731,86268,41227	182	22600,71387,98507
150	21760,91259,05568	183	22624,51089,73043
151	21789,76947,29317	184	22648,17823,00954
152	21818,43587,94477	185	22671,71728,40301
153	21846,91430,81760	186	22695,12944,21792
154	21875,20720,83646	187	22718,41606,53650
155	21903,31698,17029	188	22741,57849,26368
156	21931,24598,35446	189	22764,61804,17324
157	21958,99652,40923	190	22787,53600,95283
158	21986,57086,95442	191	22810,33367,24773
159	22013,97124,32045	192	22833,01228,70355
160	22041,19982,65592	193	22855,57309,00777
161	22068,25876,03185	194	22878,01729,93023
162	22095,15014,54263	195	22900,34611,36252
163	22121,87604,40396	196	22922,56071,35648
164	22148,43848,04770	197	22944,66226,16159
165	22174,83944,21391	198	22966,65190,26153
166	22201,08088,04006	199	22988,53076,40971
167	22227,16471,14758	200	23010,29995,66398

	Logarithmi.		*Logarithmi.*
201	23031,96057,42049	234	23692,15857,41014
202	23053,51369,44662	235	23710,67862,27174
203	23074,96037,91321	236	23729,12002,97011
204	23096,30167,42590	237	23747,48346,01010
205	23117,53861,05575	238	23765,76957,05651
206	23138,67220,36915	239	23783,97900,94814
207	23159,70345,45692	240	23802,11241,71161
208	23180,63334,96276	241	23820,17042,57487
209	23201,46286,11105	242	23838,15365,98043
210	23222,19294,73392	243	23856,06273,59831
211	23242,82455,29769	244	23873,89826,33873
212	23263,35860,92875	245	23891,66084,36453
213	23283,79603,43874	246	23909,35107,10338
214	23304,13773,34919	247	23926,96953,25967
215	23324,38459,91561	248	23944,51680,82622
216	23344,53751,15093	249	23961,99347,09574
217	23364,59733,84853	250	23979,40008,67204
218	23384,56493,60460	251	23996,73721,48104
219	23404,44114,84012	252	24014,00540,78154
220	23424,22680,82221	253	24031,20521,17582
221	23443,92273,68511	254	24048,33716,61994
222	23463,52974,45064	255	24065,40180,43396
223	23483,04863,04816	256	24082,39965,31185
224	23502,48018,33416	257	24099,33123,33129
225	23521,82518,11136	258	24116,19705,96323
226	23541,08439,14740	259	24132,99764,08125
227	23560,25857,19312	260	24149,73347,97082
228	23579,34847,00045	261	24166,40507,33828
229	23598,35482,33989	262	24183,01291,31975
230	23617,27836,01759	263	24199,55748,48976
231	23636,11979,89214	264	24216,03926,86983
232	23654,87984,89090	265	24232,45873,93681
233	23673,55921,02602	266	24248,81636,63107
234	23692,15857,41014	267	24265,11261,36458

	Logarithmi.		*Logarithmi.*
267	24265,11261,36458	301	24785,66495,59384
268	24281,34794,02879	302	24800,06942,95715
269	24297,52280,00241	303	24814,42628,50231
270	24313,63764,15899	304	24828,73583,60875
271	24329,69290,87441	305	24842,99839,34679
272	24345,68904,03420	306	24857,21426,48158
273	24361,62647,04076	307	24871,38375,47719
274	24377,50562,82039	308	24885,50716,50044
275	24393,32693,83026	309	24899,58479,42483
276	24409,09082,06522	310	24913,61693,83427
277	24424,79769,06445	311	24927,60389,02684
278	24440,44795,91808	312	24941,54594,01844
279	24456,04203,27360	313	24955,44337,54645
280	24471,58031,34222	314	24969,29648,07321
281	24487,06319,90508	315	24983,10553,78960
282	24502,49108,31936	316	24996,87082,61840
283	24517,86435,52429	317	25010,59262,21775
284	24533,18340,04704	318	25024,27119,98443
285	24548,44860,00851	319	25037,90683,05718
286	24563,66033,12904	320	25051,49978,31991
287	24578,81896,73399	321	25065,05032,40487
288	24593,92487,75923	322	25078,55871,69583
289	24608,97842,75655	323	25092,02522,33110
290	24623,97997,89896	324	25105,45010,20661
291	24638,92988,98591	325	25118,83360,97887
292	24653,82851,44842	326	25132,17600,06794
293	24668,67620,35411	327	25145,47752,66029
294	24683,47330,41216	328	25158,73843,71168
295	24698,22015,97816	329	25171,95897,94997
296	24712,91711,05894	330	25185,13939,87789
297	24727,56449,31721	331	25198,27993,77572
298	24742,16264,07626	332	25211,38083,70404
299	24756,71188,32443	333	25224,44233,50632
300	24771,21254,71966	334	25237,46466,81156

	Logarithmi.		*Logarithmi.*
334	25237,46466,81156	367	25646,66064,25209
335	25250,44807,03685	368	25658,47818,67352
336	25263,39277,38984	369	25670,26366,15906
337	25276,29900,87134	370	25682,01724,06699
338	25289,16700,27765	371	25693,73909,61505
339	25301,99698,20308	372	25705,42939,88190
340	25314,78917,04226	373	25717,08831,80869
341	25327,54378,99250	374	25728,71602,20048
342	25340,26106,05614	375	25740,31267,72772
343	25352,94120,04277	376	25751,87844,92766
344	25365,58442,57153	377	25763,41350,20579
345	25378,19095,07327	378	25774,91799,83723
346	25390,76098,79278	379	25786,39209,96807
347	25403,29474,79087	380	25797,83596,61681
348	25415,79243,94658	381	25809,24975,67562
349	25428,25426,95918	382	25820,63362,91171
350	25440,68044,35028	383	25831,98773,96862
351	25453,07116,46582	384	25843,31224,36753
352	25465,42663,47813	385	25854,60729,50850
353	25477,74705,38782	386	25865,87304,67175
354	25490,03262,02579	387	25877,10965,01891
355	25502,28353,05509	388	25888,31725,59421
356	25514,49997,97288	389	25899,49601,32571
357	25526,68216,11219	390	25910,64607,02650
358	25538,83026,64387	391	25921,76757,39587
359	25550,94448,57832	392	25932,86067,02046
360	25563,02500,76729	393	25943,92550,37543
361	25575,07201,90566	394	25954,96221,82557
362	25587,08570,53317	395	25965,97095,62646
363	25599,06625,03611	396	25976,95185,92551
364	25611,01383,64906	397	25987,90506,76312
365	25622,92864,45647	398	25998,83072,07369
366	25634,81085,39441	399	26009,72895,68675
367	25646,66064,25209	400	26020,59991,32796

	Logarithmi.		*Logarithmi.*
401	26031,44372,62018	434	26374,89729,51251
402	26042,26053,08447	435	26384,89256,95464
403	26053,05046,14111	436	26394,86489,26859
404	26063,81365,11060	437	26404,81436,97042
405	26074,55023,21467	438	26414,74110,50410
406	26085,26033,57719	439	26424,64520,24212
407	26095,94409,22522	440	26434,52676,48619
408	26106,60163,08988	441	26444,38589,46784
409	26117,23308,00734	442	26454,22269,34909
410	26127,83856,71974	443	26464,03726,22307
411	26138,41821,87607	444	26473,82970,11462
412	26148,97216,03313	445	26483,60010,98093
413	26159,50051,65640	446	26493,34858,71214
414	26170,00341,12090	447	26503,07523,13194
415	26180,48096,71209	448	26512,78013,99814
416	26190,93330,62674	449	26522,46341,00332
417	26201,36054,97376	450	26532,12513,77534
418	26211,76281,77504	451	26541,76541,87796
419	26222,14022,96630	452	26551,38434,81138
420	26232,49290,39790	453	26560,98202,01283
421	26242,82095,83567	454	26570,55852,85710
422	26253,12450,96167	455	26580,11396,65711
423	26263,40367,37504	456	26589,64842,66443
424	26273,65856,59273	457	26599,16200,06985
425	26283,88930,05031	458	26608,65478,00387
426	26294,09599,10272	459	26618,12685,53726
427	26304,27875,02502	460	26627,57831,68157
428	26314,43769,01317	461	26637,00925,38965
429	26324,57292,18472	462	26646,41975,55613
430	26334,68455,57959	463	26655,80991,01795
431	26344,77270,16073	464	26665,17980,55488
432	26354,83746,81491	465	26674,52952,88995
433	26364,87896,35337	466	26683,85916,69000
434	26374,89729,51251	467	26693,16880,56611

	Logarithmi.		*Logarithmi.*
467	26693,16880,56611	501	26998,37725,86725
468	26702,45853,07412	502	27007,03717,14502
469	26711,72842,71508	503	27015,67985,05593
470	26720,97857,93572	504	27024,30536,44553
471	26730,20907,12890	505	27032,91378,11866
472	26739,41998,63409	506	27041,50516,83980
473	26748,61140,73781	507	27050,07959,33334
474	26757,78341,67409	508	27058,63712,28392
475	26766,93609,62487	509	27067,17782,33676
476	26776,06952,72049	510	27075,70176,09794
477	26785,18379,04011	511	27084,20900,13471
478	26794,27896,61212	512	27092,69960,97583
479	26803,35513,41456	513	27101,17365,11182
480	26812,41237,37559	514	27109,63118,99528
481	26821,45076,37383	515	27118,07229,04119
482	26830,47038,23885	516	27126,49701,62721
483	26839,47130,75151	517	27134,90543,09394
484	26848,45361,64441	518	27143,29759,74523
485	26857,41738,60226	519	27151,67357,84846
486	26866,36269,26229	520	27160,03343,63480
487	26875,28961,21463	521	27168,37723,29952
488	26884,19822,00271	522	27176,70503,00226
489	26893,08859,12362	523	27185,01688,86727
490	26901,96080,02851	524	27193,31286,98373
491	26910,81492,12297	525	27201,59303,40596
492	26919,65102,76736	526	27209,85744,15374
493	26928,46919,27723	527	27218,10615,21255
494	26937,26948,92365	528	27226,33922,53381
495	26946,05198,93357	529	27234,55672,03519
496	26954,81676,49020	530	27242,75869,60079
497	26963,56388,73333	531	27250,94521,08147
498	26972,29342,75972	532	27259,11632,29505
499	26981,00545,62339	533	27267,27209,02657
500	26989,70004,33602	534	27275,41257,02856

	Logarithmi.		*Logarithmi.*
534	27275,41257,02856	567	27535,83058,89291
535	27283,53782,02123	568	27543,48335,71102
536	27291,64789,69277	569	27551,12266,39507
537	27299,74285,69956	570	27558,74855,67249
538	27307,82275,66639	571	27566,36108,24585
539	27315,88765,18674	572	27573,96028,79302
540	27323,93759,82297	573	27581,54621,96739
541	27331,97265,10657	574	27589,11892,39797
542	27339,99286,53839	575	27596,67844,68963
543	27347,99829,58885	576	27604,22483,42321
544	27355,98899,69818	577	27611,75813,15573
545	27363,96502,27664	578	27619,27838,42053
546	27371,92642,70474	579	27626,78563,72744
547	27379,87326,33343	580	27634,27993,56294
548	27387,80558,48437	581	27641,76132,39033
549	27395,72344,45009	582	27649,22984,64989
550	27403,62689,49424	583	27656,68554,75901
551	27411,51598,85179	584	27664,12847,11240
552	27419,39077,72920	585	27671,55866,08218
553	27427,25131,30470	586	27678,97616,01809
554	27435,09764,72843	587	27686,38101,24761
555	27442,92983,12268	588	27693,77326,07614
556	27450,74791,58206	589	27701,15294,78710
557	27458,55195,17373	590	27708,52011,64214
558	27466,34198,93758	591	27715,87480,88126
559	27474,11807,88642	592	27723,21706,72292
560	27481,88027,00620	593	27730,54693,36426
561	27489,62861,25616	594	27737,86444,98119
562	27497,36315,56906	595	27745,16965,72855
563	27505,08394,85135	596	27752,46259,74024
564	27512,79103,98334	597	27759,74331,12937
565	27520,48447,81944	598	27767,01183,98841
566	27528,16431,18827	599	27774,26822,38931
567	27535,83058,89291	600	27781,51250,38364

	Logarithmi.		*Logarithmi.*
601	27788,74472,00274	634	28020,89257,88173
602	27795,96491,25782	635	28027,73725,29198
603	27803,17312,14015	636	28034,57115,64841
604	27810,36938,62113	637	28041,39432,33535
605	27817,55374,65247	638	28048,20678,72116
606	27824,72624,16629	639	28055,00858,15840
607	27831,88691,07526	640	28061,79973,98389
608	27839,03579,27273	641	28068,58029,51882
609	27846,17292,63288	642	28075,35028,06885
610	27853,29835,01077	643	28082,10972,92422
611	27860,41210,24255	644	28088,85867,35981
612	27867,51422,14556	645	28095,59714,63527
613	27874,60474,51842	646	28102,32517,99508
614	27881,68371,14117	647	28109,04280,66870
615	27888,75115,77542	648	28115,75005,87059
616	27895,80712,16443	649	28122,44696,80037
617	27902,85164,03324	650	28129,13356,64286
618	27909,88475,08882	651	28135,80988,56819
619	27916,90649,02012	652	28142,47595,73192
620	27923,91689,49825	653	28149,13181,27507
621	27930,91600,17658	654	28155,77748,32427
622	27937,90384,69082	655	28162,41299,99178
623	27944,88046,65917	656	28169,03839,37566
624	27951,84589,68242	657	28175,65369,55978
625	27958,80017,34408	658	28182,25893,61396
626	27965,74333,21043	659	28188,85414,59401
627	27972,67540,83072	660	28195,43935,54187
628	27979,59643,73720	661	28202,01459,48564
629	27986,50645,44527	662	28208,57989,43970
630	27993,40549,45358	663	28215,13528,40477
631	28000,29359,24413	664	28221,68079,36802
632	28007,17078,28239	665	28228,21645,30310
633	28014,03710,01736	666	28234,74229,17030
634	28020,89257,88173	667	28241,25833,91655

	Logarithmi.			*Logarithmi.*	
667	28241,25833,91655		701	28457,18017,96666	
668	28247,76462,47555		702	28463,37112,12981	
669	28254,26117,76782		703	28469,55325,01982	
670	28260,74802,70083		704	28475,72659,14211	
671	28267,22520,16899		705	28481,89116,99140	
672	28273,69273,05383		706	28488,04701,05180	
673	28280,15064,22398		707	28494,19413,79690	
674	28286,59896,53532		708	28500,33257,68977	
675	28293,03772,83102		709	28506,46235,18307	
676	28299,46695,94164		710	28512,58348,71908	
677	28305,88668,68514		711	28518,69600,72977	
678	28312,29693,86706		712	28524,79993,63686	
679	28318,69774,28050		713	28530,89529,85187	
680	28325,08912,70624		714	28536,98211,77617	
681	28331,47111,91279		715	28543,06041,80108	
682	28337,84374,65648		716	28549,13022,30786	
683	28344,20703,68153		717	28555,19155,66780	
684	28350,56101,72012		718	28561,24444,24230	
685	28356,90571,49243		719	28567,28890,38288	
686	28363,24115,70675		720	28573,32496,43127	
687	28369,56737,05955		721	28579,35264,71943	
688	28375,88438,23551		722	28585,37197,56964	
689	28382,19221,90763		723	28591,38297,29453	
690	28388,49090,73726		724	28597,38566,19715	
691	28394,78047,37420		725	28603,38006,57099	
692	28401,06094,45676		726	28609,36620,70009	
693	28407,33234,61181		727	28615,34410,85904	
694	28413,59470,45485		728	28621,31379,31304	
695	28419,84804,59011		729	28627,27528,31797	
696	28426,09239,61056		730	28633,22860,12046	
697	28432,32778,09801		731	28639,17376,95786	
698	28438,55422,62316		732	28645,11081,05839	
699	28444,77175,74568		733	28651,03974,64113	
700	28450,98040,01426		734	28656,96059,91607	

	Logarithmi.		*Logarithmi.*
734	28656,96059,91607	767	28847,95363,94898
735	28662,87339,08419	768	28853,61220,03151
736	28668,77814,33750	769	28859,26339,80143
737	28674,67487,85905	770	28864,90725,17248
738	28680,56361,82304	771	28870,54378,05096
739	28686,44438,39483	772	28876,17300,33574
740	28692,31719,73098	773	28881,79493,91832
741	28698,18207,97933	774	28887,40960,68289
742	28704,03905,27903	775	28893,01702,50631
743	28709,88813,76058	776	28898,61721,25819
744	28715,72935,54588	777	28904,21018,80091
745	28721,56272,74829	778	28909,79596,98969
746	28727,38827,47267	779	28915,37457,67256
747	28733,20601,81540	780	28920,94602,69048
748	28739,01597,86446	781	28926,51033,87730
749	28744,81817,69947	782	28932,06753,05985
750	28750,61263,39170	783	28937,61762,05794
751	28756,39937,00417	784	28943,16062,68444
752	28762,17840,59164	785	28948,69656,74525
753	28767,94976,20070	786	28954,22546,03941
754	28773,71345,86977	787	28959,74732,35906
755	28779,46951,62919	788	28965,26217,48956
756	28785,21795,50121	789	28970,77003,20942
757	28790,95879,50007	790	28976,27091,29044
758	28796,69205,63205	791	28981,76483,49768
759	28802,41775,89548	792	28987,25181,58949
760	28808,13592,28079	793	28992,73187,31760
761	28813,84656,77057	794	28998,20502,42710
762	28819,54971,33960	795	29003,67128,65647
763	28825,24537,95488	796	29009,13067,73767
764	28830,93358,57569	797	29014,58321,39611
765	28836,61435,15362	798	29020,02891,35073
766	28842,28769,63260	799	29025,46779,31399
767	28847,95363,94898	800	29030,89986,99194

	Logarithmi.		*Logarithmi.*
801	29036,32516,08424	834	29211,66050,63774
802	29041,74368,28416	835	29216,86475,48360
803	29047,15545,27868	836	29222,06277,43902
804	29052,56048,74845	837	29227,25457,99326
805	29057,95880,36787	838	29232,44018,63028
806	29063,35041,80509	839	29237,61960,82870
807	29068,73534,72207	840	29242,79286,06188
808	29074,11360,77459	841	29247,95995,79791
809	29079,48521,61227	842	29253,12091,49965
810	29084,85018,87865	843	29258,27574,62474
811	29090,20854,21116	844	29263,42446,62566
812	29095,56029,24118	845	29268,56708,94969
813	29100,90545,59407	846	29273,70363,03902
814	29106,24404,88920	847	29278,83410,33071
815	29111,57608,73998	848	29283,95852,25671
816	29116,90158,75386	849	29289,07690,24395
817	29122,22056,53242	850	29294,18925,71429
818	29127,53303,67132	851	29299,29560,08459
819	29132,83901,76042	852	29304,39594,76670
820	29138,13852,38372	853	29309,49031,16752
821	29143,43157,11944	854	29314,57870,68901
822	29148,71817,54005	855	29319,66114,72817
823	29153,99835,21227	856	29324,73764,67715
824	29159,27211,69712	857	29329,80821,92320
825	29164,53948,54993	858	29334,87287,84871
826	29169,80047,32038	859	29339,93163,83124
827	29175,05509,55255	860	29344,98451,24357
828	29180,30336,78488	861	29350,03151,45365
829	29185,54530,55027	862	29355,07265,82471
830	29190,78092,37607	863	29360,10795,71521
831	29196,01023,78411	864	29365,13742,47889
832	29201,23326,29072	865	29370,16107,46481
833	29206,45001,40679	866	29375,17892,01735
834	29211,66050,63774	867	29380,19097,47621

	Logarithmi.		*Logarithmi.*
867	29380,19097,47621	901	29547,24790,97906
868	29385,19725,17649	902	29552,06537,54194
869	29390,19776,44867	903	29556,87750,31351
870	29395,19252,61862	904	29561,68430,47536
871	29400,18155,00766	905	29566,48579,20520
872	29405,16484,93257	906	29571,28197,67681
873	29410,14243,70557	907	29576,07287,06010
874	29415,11432,63440	908	29580,85848,52109
875	29420,08053,02231	909	29585,63883,22197
876	29425,04106,16808	910	29590,41392,32109
877	29429,99593,36604	911	29595,18376,97300
878	29434,94515,90610	912	29599,94838,32842
879	29439,88875,07377	913	29604,70777,53430
880	29444,82672,15017	914	29609,46195,73383
881	29449,75908,41205	915	29614,21094,06645
882	29454,68585,13182	916	29618,95473,66785
883	29459,60703,57757	917	29623,69335,67002
884	29464,52265,01307	918	29628,42681,20124
885	29469,43270,69783	919	29633,15511,38611
886	29474,33721,88705	920	29637,87827,34556
887	29479,23619,83173	921	29642,59630,19685
888	29484,12965,77860	922	29647,30921,05363
889	29489,01760,97021	923	29652,01701,02591
890	29493,90006,64491	924	29656,71971,22011
891	29498,77704,03687	925	29661,41732,73903
892	29503,64854,37612	926	29666,10986,68193
893	29508,51458,88855	927	29670,79734,14450
894	29513,37518,79592	928	29675,47976,21886
895	29518,23035,31591	929	29680,15713,99364
896	29523,08009,66213	930	29684,82948,55394
897	29527,92443,04409	931	29689,49680,98134
898	29532,76336,66730	932	29694,15912,35398
899	29537,59691,73323	933	29698,81643,74650
900	29542,42509,43932	934	29703,46876,23009

	Logarithmi.		*Logarithmi.*
934	29703,46876,23009	967	29854,26474,08300
935	29708,11610,87252	968	29858,75357,30839
936	29712,75848,73811	969	29863,23777,05077
937	29717,39590,88778	970	29867,71734,26624
938	29722,02838,37906	971	29872,19229,90800
939	29726,65592,26611	972	29876,66264,92627
940	29731,27853,59970	973	29881,12840,26835
941	29735,89623,42726	974	29885,58956,87862
942	29740,50902,79288	975	29890,04615,69854
943	29745,11692,73733	976	29894,49817,66669
944	29749,71994,29807	977	29898,94563,71877
945	29754,31808,50926	978	29903,38854,78760
946	29758,91136,40179	979	29907,82691,80314
947	29763,49979,00327	980	29912,26075,69249
948	29768,08337,33807	981	29916,69007,37995
949	29772,66212,42729	982	29921,11487,78695
950	29777,23605,28885	983	29925,53517,83214
951	29781,80516,93741	984	29929,95098,43134
952	29786,36948,38447	985	29934,36230,49761
953	29790,92900,63833	986	29938,76914,94121
954	29795,48374,70410	987	29943,17152,66964
955	29800,03371,58375	988	29947,56944,58763
956	29804,57892,27610	989	29951,96291,59718
957	29809,11937,77684	990	29956,35194,59755
958	29813,65509,07854	991	29960,73654,48528
959	29818,18607,17066	992	29965,11672,15418
960	29822,71233,03957	993	29969,49248,49538
961	29827,23387,66855	994	29973,86384,39731
962	29831,75072,03781	995	29978,23080,74573
963	29836,26287,12453	996	29982,59338,42370
964	29840,77033,90283	997	29986,95158,31166
965	29845,27313,34379	998	29991,30541,28737
966	29849,77126,41549	999	29995,65488,22598
967	29854,26474,08300	1000	30000,00000,00000